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None

(58) Field of search
UK CL (Edition K) A5T T3D T3E
INT CL* A61M
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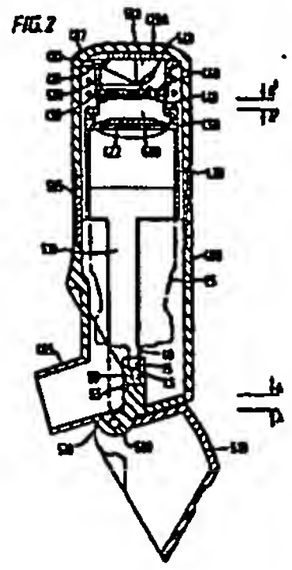
(54) Medicament dispensing device

(57) An inhaler for use with a drug delivery system (25), e.g. an aerosol dispensing container, has a diaphragm 440 and an inverted cup-shaped member 420 defining therebetween a low pressure air chamber 600 for applying a resisting pneumatic force capable of preventing actuation of the aerosol container by a loading spring 460. The resisting low pressure is released by a breath-actuator vane 550 comprising a flexible diaphragm 600 for sealing a valve port 495, the opening of which releases said positive or negative pressure. The flexible diaphragm is carried by the vane 550 such that, on initial movement of the vane, the diaphragm flexes as it is held by said positive or negative pressure against the valve seat until it is finally recessed therefrom on further movement of the vane. With the dust cap 510 closed, the spring 460 is held closed and the pressure chamber volume is a minimum. On opening of the cap, the spring urges the inverted cup downwardly which increases the pressure chamber volume until the underpressure developed therein balances the action of the spring. On inhalation, vane 550 is pivoted to open the valve port 495 whereupon spring urges the inverted cup and the aerosol further down to dispense the drug.

FIG.2



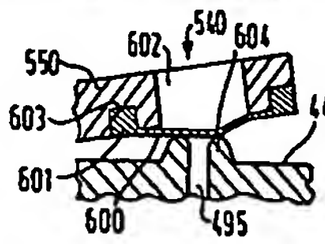


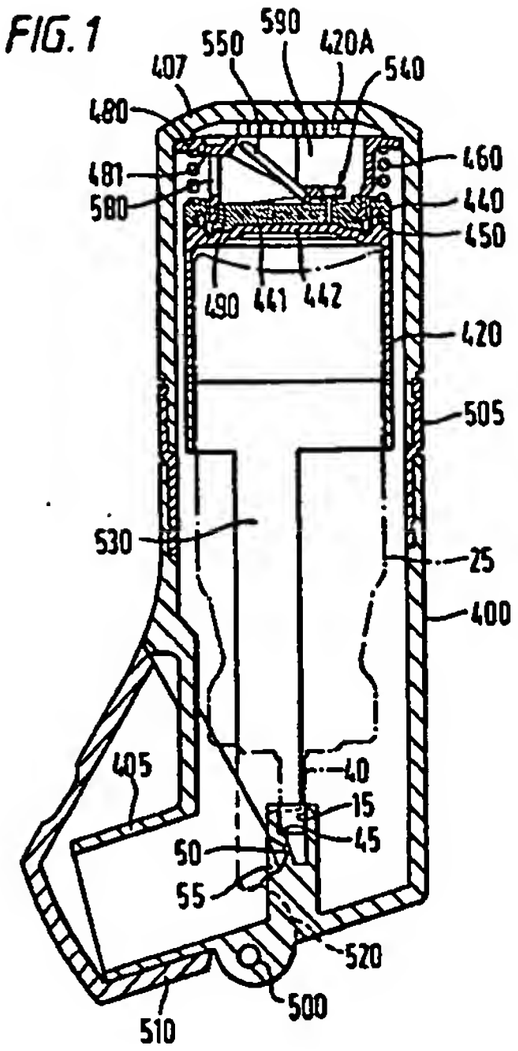
FIG.4B

GB 2 263 873 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1990.

FIG. 1



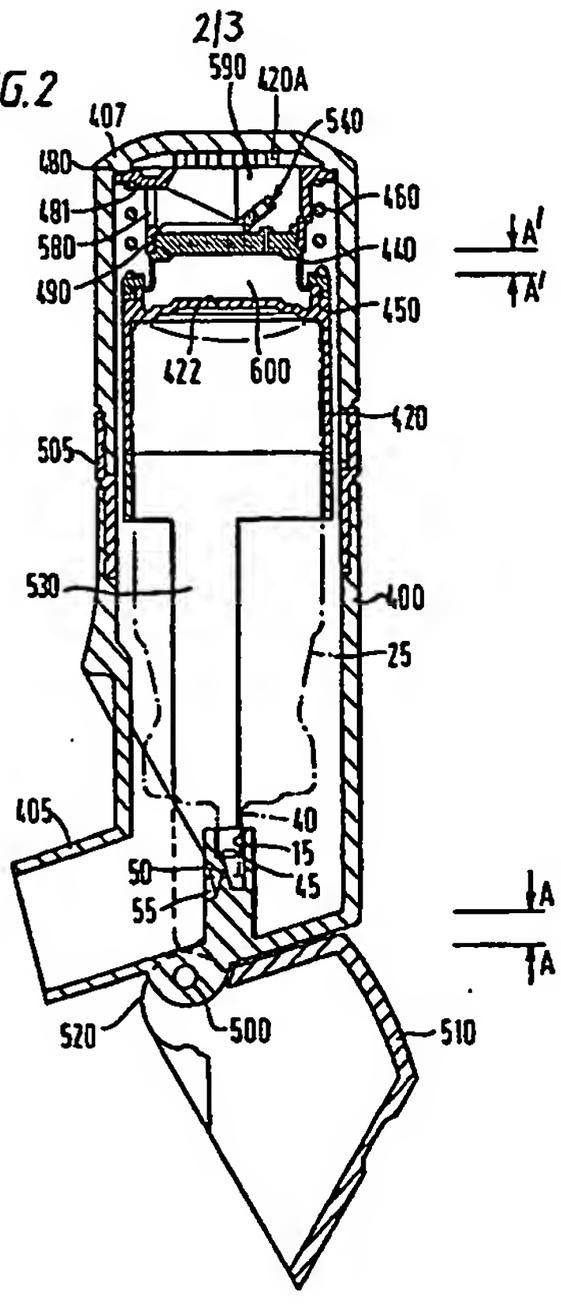
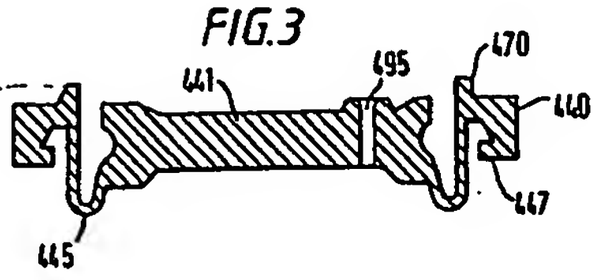


FIG.3



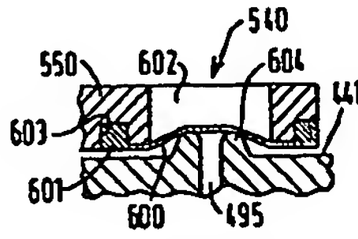


FIG.4A

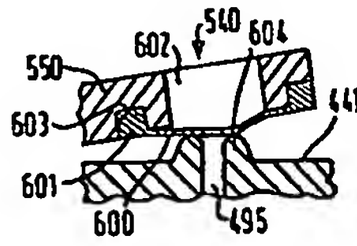


FIG.4B

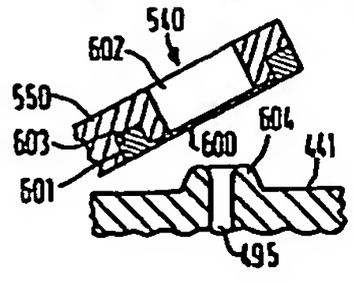


FIG.4C

MEDICAMENT DISPENSING DEVICE

This invention relates to a dispensing device, and more specifically, to a device suitable for dispensing discrete amounts of fluid or particulate material entrained in an air flow. The invention is concerned particularly, but not exclusively, with a dispensing device of the type where the metered dose is administered in response to the inhalation of the patient.

Metered dose inhalers are well known in medicine for treatment, or alleviation of the effects of respiratory complaints, for example asthma. Breath-actuated devices are also known, and have been the subject of many patent applications.

GB 1288971; GB 1297993; GB 1335378; GB 1383761; GB 1392192; GB 1413285; WO 85/01880; GB 2204799; US 4803978 and EP 0186280A describe inhalation-actuated dispensing devices for use with a pressurized aerosol dispensing container. The device includes a dispensing container and the container includes a valve capable of releasing a metered amount of the aerosol contents, when an internal spring operating the valve is compressed by a sufficient amount. The dispensing device often comprises a chamber having a mouthpiece, air inlets, actuating means for causing the actuation of the valve in the dispensing container, a latching means for releasably retaining said metering valve in a charged position, and an inhalation responsive means for releasing the latch, such that a metered amount of aerosol compound is discharged into the region of the mouthpiece. The overall objective is to give coordination of discharge of medicament from the aerosol container with inhalation of the patient, thus allowing a maximum dose of medicament to reach the bronchial passages of the lungs.

The latching means is often connected to a valve which moves from a latching position to a dispensing position in response to a partial vacuum developed upon inhalation.

EP-A-0045619 describes an inhalation device having biassing means which are alone of insufficient force to depress the container but which together are of sufficient force to do so.

EP-A-186280 describes a device which employs magnets to control the release of the aerosol container.

US 3605738 describes devices in which the aerosol container communicates with the mouthpiece via a metering chamber. A metered quantity of the aerosol compound is discharged into the metering chamber and this is conveyed to the mouthpiece via an inhalation-actuated valve.

GB 1269554 describes a device wherein the aerosol container is movable by a lever and can system into a charged position held by a latch, a pressure differential acting to trip the latch and move the valve of the container to a discharge position.

International Application No. PCT/GB91/02118 describes a metered dose inhaler in which an axially movable dose dispensing assembly is subjected to a preload capable of actuating the delivery means thereof. This preload is itself subjected to a resisting pneumatic force capable of preventing such actuation. A breath-actuated release valve is provided which, upon actuation, releases the resisting force to allow the preload to actuate the dose dispensing assembly. A pneumatic chamber is utilised for providing the resisting pneumatic force which may be a positive pressure, above atmospheric pressure or a negative pressure, below atmospheric. A breath actuated release valve opens a valve port in said pneumatic chamber to release the resisting pneumatic pressure existing therein.

It is an object of this invention to provide an inhaler, preferably a breath actuated inhaler, having an improved release valve for releasing the resisting gas pressure existing in the aforesaid chamber.

The invention provides a dispensing device for use with a drug delivery system, the dispensing device comprising means for releasing a dose of medicament from the system, the releasing means comprising means for applying a preload capable of actuating the drug delivery system to dispense a dose of medicament, means for applying a resisting pneumatic or other gas force capable of preventing actuation of the drug delivery system, and a release device capable of freeing the resisting pneumatic force to allow the preload to actuate the delivery means and dispense the medicament, wherein said resisting pneumatic force is provided by a volume of gas held at a positive or negative pressure with respect to ambient pressure, and said release means comprise a flexible plate-like sealing element which seals with a valve seat around a valve port, the opening of which releases said positive or negative pressure, the sealing element being carried by a sealing member such that, on initial movement of the sealing member, the sealing element flexes as it is held by said positive or negative pressure against the valve seat until it is finally removed therefrom on further movement of the sealing member.

Such a construction provides a more effective opening of the valve port giving a more consistent and a faster actuation of the valve.

The release device may be adapted to remove said sealing element from the valve seat in response to inhalation at an outlet nozzle of the device.

The sealing element may be a diaphragm sealing element held by the sealing member at its periphery to provide a freely flexible central part which cooperates with the valve seat.

Although this device has been described in particular relation to a system using air, it will be realised that in a closed system any suitable gas could be used.

A device according to the invention is particularly suited for use with pressurized inhalation aerosols having valves which can be actuated to dispense a dose of medicament.

However in other embodiments, a device according to the invention can be used with a dry powder drug delivery system disposed within a housing of the device, in which a dose of powdered medicament is dispensed by said system into an air flow in said housing created by inhalation at an outlet nozzle of the housing.

In some arrangements according to the invention for use with an aerosol dispensing container, the housing may include an inner sleeve for enclosing the main body of the aerosol container to define a chamber for the aerosol container. The chamber may be defined at one end by a cross member which accommodates the valve of the aerosol and seals the chamber apart from providing an aerosol outlet. The inner sleeve is preferably sealed such that there is sliding airtight contact with the sleeve chamber such that the aerosol container and inner sleeve provide a piston effect against the cross member to form the resisting load in the form of a high pressure volume capable of preventing the actuation of the aerosol valve.

In other arrangements according to the invention for use with an aerosol dispensing container, the housing may include an inner sleeve for enclosing the top portion of the main body of the aerosol container. This inner sleeve is preferably arranged to form one end of an airtight piston cylinder, bellows or diaphragm, such that movement of the inner sleeve will result in an increase in the enclosed volume within the piston cylinder, bellows or diaphragm producing a vacuum or low pressure volume to form the resisting load (force) capable of preventing the actuation of the aerosol valve.

In some embodiments, the sleeve for the dispenser may act as a sliding, airtight piston, except that instead of providing a high pressure volume, downwards motion away from the main casing creates a low pressure volume.

In a preferred arrangement, the pneumatic resisting means is formed by the inner sleeve and a fixed insert in the outer chamber linked together by flexible bellows or by a sliding

airtight seal between the sleeve and a cylinder-like extension to the insert.

According to a feature of the invention, the preload may be provided by a spring which operates, for example, against the aerosol valve. Preferably the preload is applied by a lever, pivoted in a recess housed in the outer chamber. The lever may take the form of a restraining lever preventing a loaded spring from acting on the aerosol can until operated. After operation the lever is used to reload the spring. Alternatively the lever may be connected via a plug to a spring which is in contact with the inner sleeve such that movement of the lever loads the spring.

The release means may comprise said valve port provided in the aforesaid cross member. The valve port may normally be covered by said flexible diaphragm sealing element which on actuation is opened, allowing the preload to actuate the aerosol valve as pressure in the pneumatic means returns to the rest state. In the embodiment wherein the resisting force is a positive pressure of air, opening of the valve port releases the built-up pressure, and air escapes from the enclosed volume, allowing the full force of the preload to act against the aerosol valve. In the embodiment wherein the resisting force is a vacuum or near vacuum, opening of the valve port allows air to enter the enclosed volume, again allowing the full force of the preload to act against the aerosol valve.

A preferred breath-actuating release means comprises a movable vane mechanism. This vane mechanism may be housed in the lower or upper part of the chamber, depending upon the location of the resisting element. Said flexible diaphragm sealing element is preferably attached to said vane, such that on inhalation the vane moves from its rest position closing said inlet means to its actuating position, thus moving the sealing element out of contact with the valve port, causing the opening of the valve. The vane mechanism is preferably dynamically balanced, and may be biassed towards its closed position, e.g., by a spring.

Air inlets may take the form of slots in the wall of said housing.

The medicament may be a drug per se or on any form of carrier, e.g., including a powder or a gaseous carrier.

The invention will now be described by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 is a sectional view of an inhaler embodying the invention;

Figure 2 is a sectional view of the inhaler of Figure 1 with its mouthpiece dust cap in an open position;

Figure 3 is an enlarged view of a diaphragm used in the inhaler shown in Figures 1 and 2; and

Figures 4A - 4C are respective diagrammatic illustrations of the release valve incorporated in the inhaler of Figs. 1 and 2, shown in three positions thereof.

Referring to the drawings, there is shown an inhalation device which is essentially similar in construction and operation to the device described in International Patent Application No. PCT/GB91/02118 (the disclosure of which is incorporated herein by reference) with reference to Figures 3 to 5 thereof. The modification thereof according to the present invention will be described below.

The inhalation device consists of a main body or housing 400 which is generally cylindrical in cross section, with a mouthpiece section 405 at one end and an end cap 407 housing air inlets 420 at the other end. A known type of aerosol dispensing container 25 of generally cylindrical shape is housed within the main body of the device. The aerosol dispensing container has a stem 40 which contains an aerosol dispensing valve (not shown). The bore 15 is such that it forms an airtight seal on the stem 40 of the aerosol dispensing container 25. A shoulder 45 limits and locates the position of the stem 40, which in turn locates the aerosol dispensing container 25 in position in the main body 400. A passage 50 extends from the bore 15, continuing from the shoulder 45 to interconnect with a dispensing nozzle 55.

The opposite end of the dispensing container is contained within a sleeve 420 of similar cross section to the main body 400. The longitudinal axis of both the sleeve 420 and main body 400 is generally coaxial. The sleeve is in loose sliding contact with the inner wall of the main body to allow free passage of air in the main body past the sleeve. The sleeve 420 may be held in place by connection with a diaphragm 440 held in connection with the top of the main body 400, as will now be described. Thus, the sleeve 420 effectively hangs from the top of the main body.

One end of an e.g., moulded flexible diaphragm 440 (as shown alone in Figure 3) comprising a rigid disc-like section 441, a flexible generally cylindrical wall section 445 and a stiffer connector section 447, is fitted around a purpose-made groove 450 in the sleeve, e.g. by snap-fitting. A further moulded lip 470 on the diaphragm provides a snug fit for one end of a compression spring 460. The compression spring is thus located and free to act on the sleeve. The other end of the compression spring is located by an annular shoulder 481 in a predominantly cylindrical flanged insert 480 housed in the top section of the main body 400. This insert includes a groove 490 into which the disc-like section 441 of the flexible diaphragm 440 is snap-fitted.

The joint between the diaphragm connector section 447 and inner sleeve groove 450 is arranged to be airtight and the shape of the top surface of the sleeve 422 to conform to the internal shape of the diaphragm such that in the rest position of the inhaler the two surfaces are in close proximity, and the enclosed space between them very small.

The cylindrical insert 480 is retained in place by the end cap 407 of the main body of the device. This forms a chamber 590 between the air inlet slots 420 and the rigid part 441 of the diaphragm. The chamber is provided with one or more air pathways 580 such that air may pass from the air inlet slots 420 to the mouthpiece 405. As best seen in Fig. 4A, the rigid disc-like section 441 of the diaphragm also includes a small valve port 495 which is normally covered by

a valve seal 540 housed in a vane 550 pivotally connected to the insert 480. The vane 550 may be biassed closed by a light spring flexure, a weight or a magnet (not shown).

The valve seal 540 is in the form of a flexible elastomeric diaphragm sealing element 600 having an annular rim 601. The sealing element 600 is drawn over an aperture 602 in the vane 550 whereby the central part the sealing element 600 is freely flexible. The annular rim 601 is located in an annular groove 603 provided in the vane 550 around the lower end of the aperture 602.

The vane 550 in its rest position divides the chamber 590 between the air inlets 420 and the air pathways 580 that link to the mouthpiece such that it may move from its rest position by means of a pressure drop between the air inlets and the mouthpiece. On movement of the vane to the actuated position the sealing element 540 is sufficiently moved to open the valve port 495.

The elastomeric diaphragm sealing element 600, in the closed position of the valve as shown in Figure 4A, is drawn tightly over a raised annular seat 604 provided around the valve port 495. This arrangement provides a very compliant seal, which can easily accommodate variations in alignment caused by an accumulation of tolerances and also requires only a very light return spring on the vane 550 to ensure the seal is re-made. Moreover, as the flap starts to open as shown in Figure 4B, the sealing element 600 will be retained in sealing engagement with the valve seat 604 by vacuum pressure, until the seal is suddenly and completely broken, as shown in Figure 4C, allowing the vane to drop complete (Figure 2) thereby fully opening the valve port 495 and thus ensuring consistant and fast actuation of the valve.

Other sealing arrangements could allow air to leak through the valve port, if the valve opens slowly which could lead to an inconsistent actuation of the device.

As shown in Figures 1 and 2, the end of the main body having a pivot 500, has a recess adapted to receive a cam 520 integral with a dust cap 510 operating on the pivot. The

recess further includes a passage communicating with a similar passage moulded into the internal wall of the main body 400. A cam follower in the form of a yoke 530 secured to the lower edge of the inner sleeve 420 acts on the cam such that when the dust cap is in the closed position the inner sleeve is forced by the cam follower to its uppermost position.

When the dust cap is rotated to its open position the cam profile is such that the cam follower is free to move downwards by an amount sufficient to allow actuation of the device.

In its rest position with the dust cap 510 closed, the cam follower 530 restrains the inner sleeve 420 in its uppermost position such that the enclosed space trapped between the diaphragm 440 and the top surface 422 of the inner sleeve is at a minimum and the spring 460 is compressed. The valve port 495 is closed by the valve seal element 540 and the sleeve 420 is clear of the top of the aerosol can 25 which is thus unloaded.

The dust cap is opened rotating the integral cam 520 allowing the cam follower 530 to drop by amount AA. The inner sleeve is forced downwards under the action of the spring 460. As the inner sleeve moves downwards the enclosed volume between the diaphragm 440 and inner sleeve is increased by a linear equivalent amount A'A', less than or equal to AA. Since the valve port 495 is closed this creates a low pressure volume or near vacuum in the space 600. The effect of the pressure differential between the enclosed volume 600 and atmospheric pressure is such that the inner sleeve tends to resist the action of the spring. As the inner sleeve moves downwards it contacts the aerosol can 25 and begins compression of the aerosol valve (not shown).

Downward movement of the inner sleeve will continue until there is a balance of forces between the compressive force in the spring 460 and resisting forces created by the pressure differential and compression of the aerosol valve. The geometry of the device is arranged such that this balance

occurs before the aerosol valve has been sufficiently compressed to actuate it.

A typical aerosol requires about 20N force to actuate. The spring 460 should accordingly provide a greater force, preferably 10% to 50% greater.

It may also be possible to arrange for the balance of forces to take place before the inner sleeve has contacted the aerosol can, such that the spring force is balanced by the resisting force produced on the inner sleeve by virtue of the pressure differential.

On inhalation by the patient through the mouthpiece 405, a small pressure differential is created across the vane 550 which is pivoted towards one end. The pressure differential causes the vane to move from the rest position to its actuated position. The vane and design of the air passageway 580 in the chamber 590 are such that in the actuated position air can flow freely from the air inlets 420 to the patient.

The movement of the vane 550 causes the valve seal element 540 to be moved out of a sealing position with the valve port 495 as shown in Fig. 2. Opening the valve port allows air into the gap 600 between the diaphragm and inner sleeve such that the enclosed space reaches atmospheric pressure. This causes an inbalance of forces acting on the sleeve 420 and container 25. The sleeve and container are thus forced downwards by the spring 460 resulting in the release of a measured dose of medicament through the dispensing nozzle 55 and into the mouthpiece at the same time as the patient breaths in. Thus the patient inhales air with a metered dose of medicament.

After the inhalation of the dose by the patient, the dust cap 510 is returned to its closed position. This rotates the cam 520 and causes the cam follower 530 to be forced upwards. This in turn acts on the inner sleeve 420 moving it upwards to compress the spring 460 and close the gap 600 between the diaphragm and inner sleeve top surface 422. This forces air out of the enclosed space 600 which escapes through the valve port 495 lifting the valve seal element 540. Since the valve

seal element is only lightly biassed to its closed position it presents little resistance to air flow out of the enclosed space. The aerosol can is free to return to the rest position under the action of its own aerosol valve spring.

In use the patient loads the aerosol dispensing container into the main body, which comprises upper and lower sections joined by a threaded connector part 505. When the sections of the main body 400 are separated, the aerosol can be inserted. The main body 400 can then be replaced locating the inner sleeve over the top end of the can, and the device is ready for use. As described previously, the device could be manufactured as a sealed unit.

The device may be provided with means to provide a regulated air flow to the user or inhaler. Thus a sonic device, e.g., a reed, may be provided which sounds when the inspired air flow is greater than a pre-set level, e.g., above 30 to 50 litres per minute. The sonic device may be located in the mouthpiece 55 or below the air inlet 420. The sound produced warns the patient to breathe at a lower rate.

The device may also be provided with a means such that it will not operate below a certain predetermined air flow rate, e.g., 10 to 30 litres per minute. In one embodiment the vane 550 or 110 will be biassed by a spring such that the predetermined minimum air flow is necessary for it to move to its actuated position and enable the valve seal to open.

The main body of a dispensing device, as described in this embodiment of this invention is preferably manufactured from a plastics material such as polypropylene, acetal or moulded polystyrene. It may however be manufactured from metal or another suitable material.

CLAIMS

1. A dispensing device for use with a drug delivery system, the dispensing device comprising means for releasing a dose of medicament from the system, the releasing means comprising means for applying a preload capable of actuating the drug delivery system to dispense a dose of medicament, means for applying a resisting pneumatic or other gas force capable of preventing actuation of the drug delivery system, and a release device capable of freeing the resisting pneumatic force to allow the preload to actuate the delivery means and dispense the medicament, wherein said resisting pneumatic force is provided by a volume of gas held at a positive or negative pressure with respect to ambient pressure, and said release means comprise a flexible plate-like sealing element which seals with a valve seat around a valve port, the opening of which releases said positive or negative pressure, the sealing element being carried by a sealing member such that, on initial movement of the sealing member, the sealing element flexes as it is held by said positive or negative pressure against the valve seat until it is finally removed therefrom on further movement of the sealing member.

2. A dispensing device according to Claim 1, wherein said release device is adapted to remove said sealing element from said valve seat in response to inhalation at an outlet nozzle of the device.

3. A dispensing device according to Claim 2, wherein said sealing member comprises a movable vane, which on inhalation is capable of moving from a rest position to an actuating position thereby removing said diaphragm sealing element from said valve seat.

4. A dispensing device according to Claim 3, wherein said vane constitutes one section of a pivotal mounted lever, said diaphragm sealing element being carried by a second

section of the lever on the opposite side of the pivot to said vane.

5. A dispensing device according to any preceding claim, wherein said sealing element is a flexible diaphragm sealing element held at its periphery by said sealing member to provide a freely flexible central part which cooperates with said valve seat.

6. A dispensing device according to any preceding claim, further including a housing providing a chamber for receiving said drug delivery system in the form of an aerosol container, with an inner sleeve being slidably mounted within the chamber for at least partly enclosing the main body of an aerosol container, when disposed, in use, in said chamber.

7. A dispensing device according to Claim 6, wherein said resisting pneumatic pressure is a positive pressure created by cooperation between said inner sleeve and a cross member provided in the housing, to form a piston and cylinder assembly.

8. A dispensing device according to Claim 7, wherein said valve port is provided in said cross member.

9. A dispensing device as claimed in any one of Claims 1 - 6, wherein said pneumatic resisting force is a negative pressure created inside an expandable airtight volume defined by a bellows, piston, cylinder or diaphragm.

10. A dispensing device as claimed in Claims 6 and 9, wherein said airtight volume is defined between a diaphragm which is sealed with respect to a closed end of said inner sleeve, with said valve port being provided in said diaphragm.

11. A dispensing device according to any one of Claims 6 - 8 and 10, wherein said actuating means act on said

inner sleeve, and wherein means are provided for resetting said actuating means after release thereof to cause actuation of the drug delivery system.

12. A dispensing device as claimed in Claim 11, having a housing provided with an outlet nozzle and a cover for the nozzle movably mounted on said housing, wherein a control member associated with said inner sleeve cooperates with a cam formation provided on the cover such that, when the cover is closed, the control member moves the inner sleeve to reset said actuating means and, when the cover is opened, the inner sleeve is moved under the action of the spring until the forces acting on the inner sleeve, including said pneumatic resisting force are balanced, preparatory to release of the pneumatic resisting force in response to inhalation at said nozzle.

13. A dispensing device according to any preceding claim, wherein said actuating means comprise resilient means for actuating the drug delivery system on release of said release means.

14. A dispensing device substantially as hereinbefore described with reference to the accompanying drawings.

15. A dispensing device according to any one of the preceding claims in combination with a drug delivery system in the form of an aerosol dispensing container having a valve capable of being actuated to release a metered amount of the pressurised aerosol contents.

16. A dispensing device according to any one of Claims 1 - 5, 9 - 13 in combination with a dry powder drug delivery system which is adapted to dispense, when actuated, a dose of powdered medicament.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number 9211434.7

Relevant Technical fields

(i) UK Cl (Edition K) A5T TED, THE

(ii) Int Cl (Edition 5) A61M

Search Examiner

J A WALLIS

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES: WPI

Date of Search

19 AUGUST 1992

Documents considered relevant following a search in respect of claims 1 AT LEAST

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
	NONE	

SF2(p) TP - doc99\f11000258

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

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Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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